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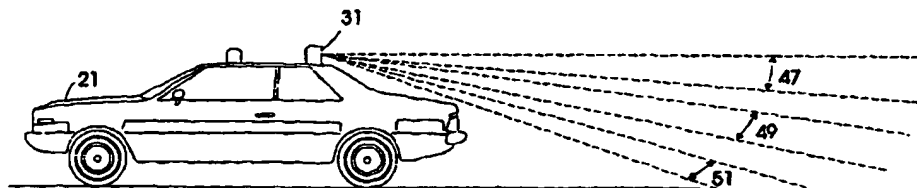
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(54) Title: SECURITY SYSTEM FOR A VEHICLE



(57) Abstract

An apparatus is provided for infrared detection of an intruder within a detection zone (47, 49, 51) surrounding a vehicle (21). An infrared sensor (31) detects a thermal energy flux reflected or radiated from a direction of interest. The sensor (31) produces an electrical input signal having an input signal level associated with the flux. The sensor is interconnected with an electronic circuit for detecting the input signal level, comparing the input signal level with a preselected trigger level, and for producing an alert signal if the input signal level becomes equal to or greater than the trigger signal level. The electronic circuit further includes an alarm, such as a visual indicator (67, 69) or an audible signal, for receiving the alert signal and for producing a warning effect detectable by an occupant within the vehicle (21) such that the occupant is made aware that an intruder may be in the vicinity of the vehicle (21).

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SECURITY SYSTEM FOR A VEHICLE

Field of the Invention

5 The present invention relates to the field of
vehicle alarms and sensors and, more particularly, is
directed towards an intelligent intrusion detection
system for use with an vehicle in either attended or
unattended mode and is especially useful for signalling
the occupant of the approach and direction of advance of
10 intruders.

Background of the Invention

Car alarms have become increasingly widespread as
the criminal industry of auto theft and chop shops have
15 proliferated, especially in large cities. Car alarms
have ranged from simple, compact electronic boxes
containing audio detectors, motion detectors, and
perhaps even light detectors, to integrated systems
having sensors custom installed throughout an vehicle's
20 body. Other such sensors involve the detection of
opening of a car door, hood, or trunk.

The response to the detection of an intrusion has
become increasingly sophisticated with greater digital
electronic capability. Responses have included sounding
25 of the car horn, activation and flashing of the
vehicle's lights, activation of an audible whooping
alarm, and more recently the playback of a human voice
with warnings ranging from stern to humorous. In some
cases the vehicle owner can digitally record his own
30 voice for replay during an alarm event. In other cases,
the alarm can actually discriminate between different
alarm levels and issue differing and increasingly more
severe warnings as the intrusion becomes increasingly
severe.

35 In non-alarm technology, proximity detectors for
vehicles have been used for alerting a vehicle operator
of approaching vehicles, pedestrians, overpasses that
are too low, and the like. However, such detection
systems are used primarily for the purpose of collision

avoidance, and as such are placed on the vehicle so as to detect objects adjacent to the vehicle that are normally difficult for the vehicle operator to see, that is, in the vehicle operator's "blind spots." For
5 example, U.S. Patent No. 4,528,563 issued on July 9, 1985 to Mikio Takeuchi entitled "Rearward Obstruction Sensing System for Automotive Vehicle" discloses four infrared illumination and illumination detection
10 transducers, each equipped with a speaker to give an alarm once each transducer was too close to an object. Other examples of this illumination technique include U.S. Patent No. 4,825,211 issued to Byung-Young Park on April 25, 1989, and entitled "Warning Device For
15 Vehicles Against an Approaching Objects," U.S. Patent No. 4,667,195 issued to Masao-Kodera on May 19, 1987, and entitled "Rear Monitor System Triggered by Occupant Leaving the Vehicle," and U.S. Patent No. 4,207,466 issued to Drage et al on June 10, 1980, entitled
20 "Infrared Proximity Detecting Apparatus." These active illumination systems depend on the reflection of light radiated by the system and on the reflectivity and size of the objects whose distance are being measured.

Other systems have employed ultrasonic devices, typically in a doppler detection mode to detect motion.
25 Such technique cannot identify where the motion is occurring, and will trigger based upon a piece of blowing debris. Ultrasonics are most useful for detecting the proximity to other large metallic objects since those types of objects provide the greatest
30 reflection and enable the strongest proximity signal to be measured.

Instances where ultrasonics have been employed include U.S. Patent No. 4,884,055 issued to Sarifino Memmola on November 28, 1989, and entitled "Antitheft
35 System," U.S. Patent No. 5,059,946 issued to Richard R. Hollowbush on October 22, 1991, U.S. Patent No. 4,694,296 issued to Sasaki et al. on September 15, 1987, and entitled "Vehicle Approach Sensing Apparatus," U.S. Patent No. 3,662,328 issued to David Spivak on May 9,

1972, and entitled "Apparatus for Determining the Proximity of Moving Vehicles," U.S. Patent No. 4,240,152 issued to Duncan et al. on December 16, 1980, and entitled "Object Indicator for Moving Vehicles," U.S. Patent No. 4,260,980 issued to Mitchell G. Bates on April 7, 1981, entitled "Blind Spot Detector for Vehicles," U.S. Patent No. 4,626,850 issued to Young H. Chay on December 2, 1986, and entitled "Vehicle Detection and Collision Avoidance Apparatus," and U.S. Patent No. 4,467,313 issued to Yoshino et al on August 21, 1984, entitled "Automotive Rear Safety Checking Apparatus." In addition, U.S. Patent No. 4,543,577 issued to Tachibana et al on September 24, 1985, entitled "Moving Vehicle Detection System for a Vehicle," discloses the use of radar to detect moving objects.

Such mechanisms listed above are all active radiating devices not specifically designed to detect individuals in all types of conditions, and especially to alert a system or a driver that someone is approaching the parked vehicle and from which direction. Direction may become an important criteria of discrimination in any detection scheme. For example, if an vehicle is left parked into a backed up position, the detection of movement in front of the vehicle, as by people walking by in the normal course of activity, may not warrant detection. Someone standing at the side of a vehicle in such a configuration, however, and especially for an extended duration would definitely warrant an alarm trigger response.

An approach system is sorely needed in the case of military, police, fire department and other security personnel who frequently need to park their vehicles in the course of execution of their duties. This is particularly true where the vehicle is of necessity used as a base from which to do paperwork, computer operations, equipment operations or other tasks that are usually performed while the vehicle is parked or stopped. This necessity is particularly keen when the

vehicles are in war zones, high risk neighborhoods or during the occurrence of an extended riot.

During the Los Angeles riots of 1992, several injuries occurred during assaults on police and fire department personnel. Typically the assaults occurred as craven, ambush style attacks and predominantly occur under cover of darkness. The necessity for such a proximity alarm is clear, for it would help our safety personnel eliminate a disadvantage in the performance of their duties.

Likewise, such a proximity system could be utilized by taxi drivers who spend much of their time parked and waiting for a radio dispatch or waiting in line at airports and hotels. Such parked drivers are vulnerable to attack from any direction if they do not keep vigilant. Indeed, a common safety practice has been the practice of backing the vehicle into a corner so that the vehicle can only be approached from the front, where an attacker can more easily be seen.

If a system were attempted to be built to indicate proximity using the technology cited above, the cost, complexity, and installation would be prohibitive. Other disadvantages include the fact that such devices are required to be attached to the vehicle in a permanent manner, making it difficult or impossible to redirect the protection zone in a different direction, or to temporarily remove the detector altogether. Further, prior art devices are not designed to provide quantitative as well as qualitative indication as to the nature of the intrusion into the detection zones. For example, a police officer completing a report in his vehicle and not observing the area around his vehicle would have a different response to an alarm indicating that someone was running up to his vehicle from behind than he would to an alarm indicating that someone was casually walking past in front of his vehicle. Existing devices, however, do not allow such a distinction.

Clearly, then, there is a need for a security detection system that indicates, either to an alarm

system or to occupants within a parked vehicle that someone is approaching the vehicle. Further, such a needed system could include a temporarily installed detector that could be repositioned as necessary on the vehicle. Such a needed system could also give a quantitative indication of the intrusion into a protection zone or zones proximate to the vehicle. Further, a sensitivity adjustment on such a needed system should be readily accessible, such that the sensitivity could be increased in instances where the car is parked in a position where intruders would approach from a distance.

Once detection is enabled, the detection signal could be utilized to activate auxiliary devices such as door or passenger lights, auxiliary alarm systems, radio transmitters, and the like. Further, such a needed device should be relatively easy to install and maintain.

Summary of the Invention

The alarm system for vehicles of the present invention utilizes one or more passive infrared motion detectors as the main sensing device in the system. At least one infrared sensor detects a thermal energy flux reflected or radiated from a direction of interest. The sensor, which is able to characterize distance and rapidity of motion, produces an electrical input signal having an input signal level associated with the energy flux. In one embodiment of the invention, the sensor may be secured to the outside of the vehicle temporarily by a permanent magnet, or hanging from some other structure on a vehicle, such as a window, door, or panel separation. Other embodiments might provide a permanent mounting of the sensor integral with the vehicle roof, trunk, an emergency light bar, a taxi cab roof light, or the like. In addition, other infrared sensors may be mounted about the vehicle in such an orientation to detect very close proximity to the vehicle.

The infrared sensors may be interconnected with an

electronic circuit capable of detecting, discriminating, and intelligently treating their input signal levels, comparing the input signal level with one or more adjustable preselected trigger levels, and for producing
5 a variety of alert signals when triggering conditions are met. In one embodiment of the invention, the electronic circuit further includes an electrical interconnection for communicating with auxiliary vehicle systems and alarms, which may further include
10 intelligent telemetry of the type and severity of the alarm condition detected.

The electronic circuits of the invention may further include varieties of alarms, such as a visual indicator, audible signals for the vehicle occupant or
15 operator, audible warning signals for the intruder, and illumination of the exterior of the car. In addition to warning the vehicle operator or owner, there is significant utility in creating a warning for the intruder. Where there are several intruders, merely
20 warning the occupant of the vehicle may be insufficient to avoid death or injury to the occupant, and bright illumination of the outside of the vehicle may provide a sufficient deterrent.

In addition, where the alarm is set to receive an alert signal and produce a warning for the occupant
25 within the vehicle, the alarm may have a variable brightness visual indicator and a variable volume audible signal which depends upon the number of intruders, the distance of the intruders away from the sensor, the speed at which the intruders are moving, or
30 the like. The indicator may be removable from the vehicle and still function by radio telemetry.

The indicator is contemplated to contain, a sensitivity adjustment readily accessible to the driver,
35 and the system may be used to activate auxiliary devices such as door or passenger lights, auxiliary alarm systems on or outside of the vehicle, and the like. Further, the present device is relatively easy to install and maintain. Other features and advantages of

the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

Brief Description of the Drawings

Other features, advantages and details of the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a combination downwardly directed view of a vehicle illustrating the location and zone coverage of multiple sensors of the invention positioned so as to protect the periphery of a vehicle;

FIGURE 2 is a side view of a single sensor utilizable in a multi sensor array shown in Figure 1;

FIGURE 3 is a side view of a vehicle illustrating the zones of coverage obtainable with multiple sensors mounted about the periphery of the vehicle;

FIGURE 4 is a downward view illustrating the azimuthal coverage obtainable with the use of a dual sensor configuration with respect to a vehicle, and illustrating approaches to the vehicle which would be detected;

FIGURE 5 is a side view of a vehicle with a roof mounted sensor illustrating the elevational zones of coverage extending to the rear of the vehicle;

FIGURE 6 is a rear perspective view of one possible sensor and circuitry housing and its associated coverings for covering and enabling operation of dual sensor elements;

FIGURE 7 is a perspective illustration of one possible control configuration which may be used to operate the sensors of FIGURES 1 - 6, and including a control panel having a directional visual alarm indicator, a sensitivity adjustment control, and an audio alarm signal enabling switch;

FIGURE 8 is a circuit schematic illustrating a single sensor analog circuit which is but one possible analog realization of the basic circuit of the present invention;

5 FIGURE 9 is a circuit schematic illustrating a dual sensor analog circuit which is but one possible realization of the sensor and circuitry of the present invention;

10 FIGURE 10 is an overall circuit schematic illustrating the differing control options possible with a signal generated with the circuits of FIGURES 8 and 9;

15 FIGURE 11 is an overall circuit schematic illustrating one possible digital realization of the present invention; FIGURE 12 is a plan view of a portable sensor unit embodying the principles of the present invention;

FIGURE 13 is a rear view of the portable sensor unit shown in FIGURE 12; and

20 FIGURE 14 is a side view of the portable sensor unit shown in FIGURES 12 and 13.

Detailed Description of the Preferred Embodiment

25 A detailed description of this invention will be begun with respect to a somewhat simplified system in order that an understanding of the invention and its operations may be quickly grasped. Variations on the fundamental system disclosed will be discussed as the fundamental system is described.

30 FIGURE 1 illustrates a top view of an vehicle 21 employing a series of close range detectors 23 about the periphery of the vehicle. The detectors 23 are shown projecting a detection area about an angle α sufficient to provide intermittent coverage between successive
35 detectors 23. The detectors 23 are located, as shown in FIGURE 1, one each at the front and rear of the vehicle 21, and four along each side of the vehicle 21. Referring to FIGURE 2, an expanded view of one possible configuration of such a sensor 23 is illustrated.

Sensor 23 may have a base portion 25 which may be magnetic or permanently affixed to the vehicle 21 body. Alternatively, a sensor may be attached to any portion of the vehicle 21, such as by hanging it over the glass window, or affixing it to a space between the vehicle 21 door and another portion of the vehicle 21's body.

As shown in Figure 2, the base portion 25 supports a sensor housing 27 which may support the necessary electronics to detect a thermal energy flux radiated from a zone of interest surrounding the vehicle 21.

The sensor 23 may be active in that it may first transmit an infrared beam in the direction of interest and then detect the reflected infrared flux. Alternatively, the sensor 23 may be passive, acting only as a detector of the thermal flux. As is shown in FIGURE 2, the sensor 23 may also include a lens 29 suitable for directing the zone of interest surrounding the vehicle 21. Lens 29 may provide high directional definition in the zones in which it receives the infrared radiation. The received radiation typically arises from heat given off by the human body which is more intense than the heat from the surrounding area.

The sensors 23 may be wired to a detector in the vehicle 21. However, the sensor housing 27 may also support telemetry circuitry to communicate with a sensor on the inside of the car. Moreover, given the high frequencies currently available for use in such an application, each sensor 23 can have its own frequency and be placed about the vehicle 21 in a manner which will allow spatial interpretation of the sensor 23 outputs on an alarm panel (not shown). For example, a set of sensors 23 could correspond to LED's (light emitting diodes) mounted on a panel surrounding an orientational schematic of the vehicle 21, and which will immediately indicate the presence and spatial location, with respect to the periphery of the vehicle, of the intruder.

The use of a permanent magnet in the base portion

25 allows the sensor 23 to be placed on and removed from the vehicle quickly, useful in instances where the vehicle is to be stored or unattended, to prevent theft of the sensors 23. Other embodiments might provide the sensor 23 to be mounted integrally with an emergency light bar, a taxi cab roof light, or the like (not shown).

Referring to FIGURE 3, a side view of the sensor 23 shows an instance where the zones of interest, represented by dashed angled lines, are directed downwardly. In this configuration, the maximum sensitivity is set for an individual approaching the car in a crouched or crawling position. The lens 29 is very useful in adjusting the density and direction of the zone of interest. One such lens 29 which is useful is the fresnel lens which has advantages relating to its flat profile.

Referring to FIGURE 4, a top view of vehicle 21 is illustrated with a different configuration sensor than the sensor 23 which was illustrated in FIGURES 1 - 3. In FIGURE 4, a sensor 31 is shown mounted atop the roof of vehicle 21. In the configuration of Figure 4, the sensor 31 is a sensor pair mounted within a single housing (to be shown). Preferably the sensor 31 is mounted aftwardly of the vehicle 21's roof to give it the best view angle of the zone to the rear of the vehicle 21. It is contemplated that the sensor 31 should have several zones, some of which overlap. The version of sensor 31 shown in Figure 4 has two zones, the zones shown by the dashed line angle markers and arc circles. One zone 33 extends to the left rear area of the vehicle 21 while the another zone 35 extends to the right rear area of the vehicle 21, taken with respect to a driver seated in vehicle 21.

There is an overlap zone 37 which is directed rearwardly of vehicle 21. The overlap zone can serve two purposes. First, it eliminates "blind spots" in the detection zone. Second, it can assist an alarm panel in showing movement and position. For simple position, an

alarm panel would show both zones being occupied which, in the case of a two zone detector could indicate an approach from the rear of the vehicle 21, or a pair of intruders. A set of wavy lines represent the paths of approaching intruders. Paths 39, 41 and 43 represent the approach of intruders. An intruder following path 39 will be detected in zone 35, an intruder following path 43 will be detected in zone 33, while an intruder following path 41 will be detected in both the zones 33 and 35.

As the number of zones 33 and 35 are increased, both the angular direction of travel and numbers of intruders will become detectable on an alarm panel. As the zones, such as zones 33 and 35 become more numerous and narrowly defined the detected movement and positioning of intruders will be more discernable.

It is understood that further zones, identical to zones 33 and 35 may be provided, directed toward the front or sides of the vehicle 21 to provide additional coverage. The two zone approach is considered a minimum level of detection to enable a safety worker to most quickly determine the presence and rear quadrant location of an intruder so that he may have a maximum chance to learn of the presence of and react to the intruder before the intruder can have an opportunity to attack. In FIGURE 4, the vehicle 21 is shown as being equipped with a light bar 45 which may be triggerable upon the detection of an intruder utilizing electronics which will be subsequently shown.

A fresnel lens (not shown in FIGURES 4 or 5) can be employed to direct the zone of interest as was shown for the sensors 23 of FIGURES 1 - 3. Referring to FIGURE 5, a side view of the vehicle 21 shown in FIGURE 4 illustrates in dashed line format the zones of interest. These zones do not overlap and in fact create empty zone spaces between the zones, shown as zones 47, 49, and 51. The arrangement of a fresnel lens to give alternating zones actually increases the gain in the zones 47, 49, and 51 of interest without compromising the integrity of

the system. This is so since it is impossible to approach the vehicle 21 within a space between the zones 47, 49, and 51. The spaces between the zones 47, 49, and 51 represent horizontal ramps leading to the sensor 31 which cannot be occupied throughout the approach to the sensor 31.

FIGURE 6 illustrates a closeup view of the sensor 31 shown in FIGURES 4 and 5. The sensor 31 includes a housing 53 having a sloped rear surface 55 to lessen the possibility of catching on overhanging structures and also to help lessen wind resistance. FIGURE 6 illustrates the sensor 31 as it would appear from the left rear quadrant of a vehicle 21 to which it was attached. The housing 53 defines a first window 57 directed to the left rear zone 33 and a second window 59 directed to the right rear zone 35 of the vehicle 21.

Each of the windows 57 and 59 are covered with a covering 61 which may be a clear or opaque sheet of plastic. Covering 61 may be a multi-section fresnel lens or provide a covering for such a multi-section fresnel lens. The covering 61, in conjunction with the housing 53 will protect and contain the electronics and circuit boards (not shown) which will perform the bulk of the electronic detection of intruders.

Referring to FIGURE 7, an example of a simple alarm and control panel 65 is shown. A first light emitting diode 67 is located upwardly and to the left of the panel 65, adjacent the word "left." A second light emitting diode 69 is located upwardly and to the right of the panel 65, adjacent the word "right." In the lower left corner of the panel 65 is located a sensitivity dial 71 adjacent the terms "sensitivity," "min," and "max," and can include a power switch. This control enables the vehicle 21 operator to adjust the sensitivity of the infrared detection electronics within the housing 31 of FIGURE 6. To the lower right of the panel 65 is a switch 73 which can turn on and off an audio alarm. Such audio disablement may be advantageous during stakeout and at night where the LED's 67 and 69

would provide sufficient warning, and where an audible alarm would draw unnecessary attention to the vehicle 21.

5 It is understood that the panel 65 may have electrical connections extending between it and the housing 31, or in the alternative, the housing 31 may contain radio telemetry and control which would enable the panel 65 and its transmit and receive electronics to be transported with the vehicle 21 operator, especially
10 where the vehicle 21 operator leaves the vehicle temporarily to perform a task nearby. Where an electrical connection is to be had, the control panel of FIGURE 7 contemplates only a small number of conductors to complete the connection. A wire for the right LED
15 69, a wire for the left LED 67, a wire to carry the tone signal, a wire for the sensitivity control 71, power, and a ground potential wire may be all that is necessary.

The sensors 23 or sensor 31 may be connected to
20 control electronics which may dictate their operation and perform other tasks. It is understood that the circuit configurations may admit to either an analog implementation or a digital implementation. One possible circuit configuration, which is largely analog,
25 begins with reference to FIGURE 8. FIGURE 8 illustrates a circuit for a single sensor 23. The circuit shown therein is for detecting the input signal level, comparing the input signal level with a preselected trigger level, and for producing an alert signal if the
30 input signal level becomes equal to or greater than the trigger signal level. All components begin with an S designation to illustrate the single sensor configuration.

Referring to FIGURE 8, at the leftmost side a lens
35 101 is shown in front of a detector SPY1. The detector SPY1 is fed by a power supply labeled SBB, which will be shown. Detector SPY1 is grounded, and has a laterally extending signal wire which is connected to ground through a resistor SR3. The laterally extending signal

wire is connected to the positive input of an operational amplifier labeled SU1-A. The negative input of operational amplifier SU1-A is connected with the output of operational amplifier SU1-A and to the
5 negative input of an operational amplifier SU1-B through the series combination of a resistor SR4 and a capacitor SC5.

The negative input of operational amplifier SU1-B is connected to its output through a parallel
10 combination of a capacitor SC6 and a resistor SR5. The output of operational amplifier SU1-B is connected with the negative input of operational amplifier SU1-C through the series combination of a resistor SR6 and a capacitor SC7. The negative input of operational
15 amplifier SU1-C is connected to its output through a parallel combination of a capacitor SC8 and a resistor SR7. The output of operational amplifier SU1-C is connected with the negative input of operational amplifier SU1-D through the series combination of a
20 resistor SR8 and a capacitor SC9. The negative input of operational amplifier SU1-D is connected to its output through a parallel combination of a capacitor SC10 and a resistor SR9.

The voltage reference SBB is connected to ground
25 through a series combination of resistors SR10, SR11, SR12, and SR13. A junction between resistors SR10 and SR11 is connected to the positive input of operational amplifier SU1-D and to the positive input of operational amplifier SU2-A. A junction between resistors SR11 and
30 SR12 is connected to the positive input of operational amplifier SU1-C. A junction between resistors SR12 and SR13 is connected to the positive input of operational amplifier SU1-B.

A pair of operational amplifiers SU2-B and SU2-C
35 are set up to provide voltage references to a pair of voltage comparators SU3-A and SU3-B. The negative input and output of operational amplifier SU2-A is connected into the positive input of operational amplifier SU2-B, to the positive input of an operational amplifier SU4-B,

and to ground through a series combination of resistors SR14 and SR15, and a variable resistor SR16. Variable resistor SR16 is operated with sensitivity dial 71, previously shown. The junction between resistors SR14 and SR15 is made available first to the positive input of operational amplifier SU2-C and then to ground through a capacitor SC-11.

The output of operational amplifier SU2-B is connected to the positive input of voltage comparator SU3-A and an upper trip voltage source 103. The output of operational amplifier SU2-B is also made available through a resistor SR17 to the negative input of operational amplifier SU2-B. The output of operational amplifier SU2-C is made available to both the negative input of SU2-C and the negative input of operational amplifier SU2-B through resistor SR18.

The positive input of voltage comparator SU3-A is connected to the output of operational amplifier SU2-B. The output of operational amplifier SU1-D is made available to the negative input of voltage comparator SU3-A and the positive input of voltage comparator SU3-B. The negative input of voltage comparator SU3-B is connected to the output and negative input of operational amplifier SU2-C is connected to a lower trip voltage source 105.

The outputs of voltage comparators SU3-A and SU3-B are connected through a resistor SR20 to a negative input of operational amplifier SU4-B. The negative input of operational amplifier SU4-B is connected to a power source AA through a resistor SR19 and is connected to ground through a capacitor SC12. The output of operational amplifier SU4-B is connected to the base of a power transistor SQ1. Power transistor SQ1 has a collector connected to power source SAA and an emitter connected through a resistor SR26 to ground through a light emitting diode SLED1.

The output of operational amplifier SU4-B may be connected to an amenity control signal 107. The output of operational amplifier SU4-B may also be connected

through a diode SD1 to the negative input of an operational amplifier SU4-A, and to ground through a capacitor SC13. The output of operational amplifier SU4-A is connected to its negative input through a resistor SR24. Power supply SAA is connected through resistor SR21 and resistor SR22 to ground.

The junction between resistors SR21 and SR22 is connected to the positive input of an operational amplifier SU4-A. The junction between resistors SR21 and SR22 is also connected through a resistor SR23 to the output of operational amplifier SU4-A. The output of operational amplifier SU4-A is connected through a resistor SR25 and a speaker SSP1, to ground. The junction between SR25 and SSP1 is also connected to ground through SSW1.

The power supplies SAA and SBB are formed by a battery power supply SBATT1 having one end connected to ground and another end connected through a resistor SR1 to the power potential SAA. Power source point SAA feeds the main circuit of FIGURE 8 as previously shown. Power source SAA is connected to ground through a zener diode SVR1 and is also connected to ground through a capacitor SC2. Power source SAA is connected to the input of a conditioner SU5 through a resistor SR2. The input of conditioner SU5 is connected to ground through a capacitor SC2. The output of conditioner SU5 forms the power source SBB and is also connected to ground through the parallel combination of capacitors SC3 and SC3.

Thus Figure 8 has shown one possible circuit wherein the operational amplifiers SU1-A, SU1-B, SU1-C, and SU1-D are used for signal filtering. The operational amplifier SU4-B can be used to operate an amenity control signal 107, a speaker or siren SSP1, as well as a visual indicator represented by light emitting diode SLED1.

The component values for the circuit of FIGURE 8 are given in TABLE 1 as follows:

TABLE 1

SR3, SR17, SR18, SR19, SR21, SR22, SR23 --- 51K,
 1/4w
 SR4, SR6, SR8 --- 30K, 1/4w
 SR5, SR7, SR9 --- 510K, 1/4w
 5 SR10, SR14 --- 10K, 1/4w
 SR11, SR12, SR13, SR24, SR25 --- 3.3K, 1/4w
 SR15 --- 1K, 1/4w
 SR26 --- 510 ohms, 1/2w
 SR1, SR2 --- 10 ohms 1/4w
 10 SR16 --- 100K, 3/4w, 3/4 TURN
 SC1, SC2, SC3, SC5, SC7, SC9, SC11, SC12 --- 47uf, 16
 volts
 SC6, SC8, SC10 --- .01uf, 50 volts
 SC4, SC13 --- .033uf, 50 volts
 15 SD1 --- 1N4148
 SQ1 --- 2N2222
 SVR1 --- 1N5245
 SU1, SU2 --- LM324N
 SU3 --- LM393N
 20 SU4 --- LM358N
 SU5 --- LM78L08
 SPY1 --- P2288, Hamamatsu
 SLED1 --- LN29RPP, Panasonic
 SSP1 --- EFB-RD24C411, Panasonic
 25 SSW1 --- GSR-4011-1600, CW Industries
 lens 101 --- DWA 1.2 GI 12 V1, Fresnel Technologies

Referring to FIGURE 9, one possible circuit
 utilizing dual sensors, and in which the component
 values begin with the letter D, is shown. At the
 30 leftmost side of FIGURE 9 and somewhat upwardly is a
 lens 109 is shown in front of a detector DPY1. The
 detector DPY1 is fed by a power supply labeled DBB,
 which will be shown. Detector DPY1 is grounded, and has
 a laterally extending signal wire which is connected to
 35 ground through a resistor DR1. The laterally extending
 signal wire is also connected to the positive input of
 an operational amplifier labeled DU1-A. The negative
 input of operational amplifier DU1-A is connected with
 the output of operational amplifier DU1-A and to the
 40 negative input of an operational amplifier DU1-B through
 the series combination of a resistor DR3 and a capacitor
 DC1.

The negative input of operational amplifier DU1-B
 is connected to its output through a parallel
 45 combination of a capacitor DC7 and a resistor DR9. The
 output of operational amplifier DU1-B is connected with
 the negative input of operational amplifier DU1-C

through the series combination of a resistor DR4 and a capacitor DC2. The negative input of operational amplifier DU1-C is connected to its output through a parallel combination of a capacitor DC8 and a resistor DR10. The output of operational amplifier DU1-C is connected with the negative input of operational amplifier DU1-D through the series combination of a resistor DR5 and a capacitor DC3. The negative input of operational amplifier DU1-D is connected to its output through a parallel combination of a capacitor DC9 and a resistor DR11.

A second series of amplifiers configured as filters is shown beginning at the leftmost side of FIGURE 9 and somewhat below lens 109. Lens 111 is shown in front of a detector DPY2. The detector DPY2 is fed by a power supply labeled DBB, which will be shown. Detector DPY2 is grounded, and has a laterally extending signal wire which is connected to ground through a resistor DR2. The laterally extending signal wire is also connected to the positive input of an operational amplifier labeled DU2-A. The negative input of operational amplifier DU2-A is connected with the output of operational amplifier DU2-A and to the negative input of an operational amplifier DU2-B through the series combination of a resistor DR6 and a capacitor DC4.

The negative input of operational amplifier DU2-B is connected to its output through a parallel combination of a capacitor DC10 and a resistor DR12. The output of operational amplifier DU2-B is connected with the negative input of operational amplifier DU2-C through the series combination of a resistor DR7 and a capacitor DC5. The negative input of operational amplifier DU2-C is connected to its output through a parallel combination of a capacitor DC11 and a resistor DR13. The output of operational amplifier DU2-C is connected with the negative input of operational amplifier DU2-D through the series combination of a resistor DR8 and a capacitor DC6. The negative input of operational amplifier DU2-D is connected to its output

through a parallel combination of a capacitor DC12 and a resistor DR14.

5 The voltage reference DBB is connected to ground through a series combination of resistors DR15, DR16, DR17, and DR18. A junction between resistors DR15 and DR16 is connected to the positive inputs of operational amplifiers DU1-D, DU2-D and to the positive input of an operational amplifier DU3-A. A junction between resistors DR16 and DR17 is connected to the positive
10 inputs of operational amplifiers DU1-C and DU2-C. A junction between resistors DR17 and DR18 is connected to the positive inputs of operational amplifiers DU1-B and DU2-B.

15 A pair of operational amplifiers DU3-C and DU3-D are set up to provide voltage references to two pairs of voltage comparators, the first pair being DU4-A and DU4-B and the second pair being DU4-C and DU4-D.

20 The negative input and output of operational amplifier SU3-A is connected into the positive input of operational amplifier DU3-C, to the positive input of an operational amplifiers DU5-B and DU5-C, and to ground through a series combination of resistors DR19 and DR20, and a variable resistor DR21. Variable resistor DR21 is operated with sensitivity dial 71, previously shown.
25 The junction between resistors DR19 and DR20 is made available first to the positive input of operational amplifier DU3-D and then to ground through a capacitor DC-13.

30 The output of operational amplifier DU3-C is connected to the positive input of voltage comparators DU4-A, DU4-C and upper trip voltage source 103. The output of operational amplifier DU3-C is also made available through a resistor DR22 to the negative input of operational amplifier DU3-C. The output of
35 operational amplifier DU3-D is made available to both the negative input of operational amplifier DU3-D and through resistor DR23 to the negative input of DU3-C.

The positive inputs of voltage comparators DU4-A and DU4-C are connected to the output of operational

amplifier DU3-C. The output of operational amplifier DU1-D is made available to the negative input of voltage comparator DU4-A and the positive input of voltage comparator DU4-B. The output of operational amplifier DU2-D is made available to the negative input of operational amplifier DU4-C and the positive input of voltage comparator DU4-D. The negative inputs of voltage comparators DU4-D, DU4-B, and the output and negative input of operational amplifier DU3-D are connected to lower trip voltage source 105.

The outputs of voltage comparator DU4-A and DU4-B are connected through a resistor DR25 to a negative input of operational amplifier DU5-B. The negative input of operational amplifier DU5-B is connected to a power source DAA through a resistor DR24 and is connected to ground through a capacitor DC16. The output of operational amplifier DU5-B is connected to the base of a power transistor DQ1. Power transistor DQ1 has a collector connected to power source DAA and an emitter connected through a resistor DR34 to ground through a light emitting diode DLED1.

The outputs of operational amplifiers DU4-C and DU4-D are connected through a resistor DR27 to a negative input of operational amplifier DU5-C. The negative input of operational amplifier DU5-C is connected to a power source DAA through a resistor DR26 and is connected to ground through a capacitor DC15. The output of operational amplifier DU5-C is connected to the base of a power transistor DQ2. Power transistor DQ2 has a collector connected to power source DAA and an emitter connected through a resistor DR35 to ground through a light emitting diode DLED2.

The outputs of operational amplifiers DU5-B and DU5-C may be connected to amenity control signal 107 through diodes DD3 and DD2, respectively. The output of operational amplifiers DU5-B and DU5-C are also, through diodes DD3 and DD2 respectively, connected to the negative input of an operational amplifier DU3-B, and to ground through a resistor DR28. The output of

operational amplifier DU3-A is connected to the negative input of operational amplifier DU3-B. The output of operational amplifier DU3-B is connected through a diode DD1 to the negative input of an operational amplifier DU5-A. The negative input of operational amplifier DU5-A is connected to ground through a capacitor DC14.

Power supply DAA is connected through resistor DR29 and resistor DR30 to ground. The junction between resistors DR29 and DR30 is connected to the positive input of an operational amplifier DU5-A. The junction between resistors DR29 and DR30 is also connected through a resistor DR31 to the output of operational amplifier DU5-A. The output of operational amplifier DU5-A is connected through a resistor DR33 and a speaker DSP1, to ground. The junction of DR33 and DSP1 is also connected to ground through DSW1. The output of operational amplifier DU5-A is also connected to its negative input.

The power supplies DAA and DBB are formed by a battery power supply DBATT1 having one end connected to ground and another end connected through a resistor DR36 to the power potential DAA. Power source point DAA feeds the main circuit of FIGURE 9 as previously shown. Power source DAA is connected to ground through a zener diode DVR1 and is also connected to ground through a capacitor DC17. Power source DAA is connected to the input of a conditioner DU6 through a resistor DR37. The input of conditioner DU6 is connected to ground through a capacitor DC18. The output of conditioner DU6 forms the power source DBB and is also connected to ground through the parallel combination of capacitors DC19 and DC20.

Thus Figure 9 has shown one possible circuit with a dual sensing capability. Other analog embodiments having 3 and more sensors can be built up in a similar manner. Alternatively, each sensor track may be built as shown in FIGURE 8 with full duplication of all the component parts shown there.

The component values for the circuit of FIGURE 9

are given in TABLE 2 as follows:

TABLE 2

	DR1, DR2, DR22, DR23, DR24, DR26, DR28,
	DR29, DR30, DR31 --- 51K, 1/4w
5	DR3, DR4, DR5, DR6, DR7, DR8 --- 30K, 1/4w
	DR9, DR10, DR11, DR12, DR13, DR14 --- 510K, 1/4w
	DR15, DR19 --- 10K, 1/4w
	DR16, DR17, DR18, DR32, DR33 --- 3.3K, 1/4w
	DR20, DR25, DR27 --- 1K, 1/4w
10	DR34, DR35 --- 510 ohms, 1/2w
	DR36, DR37 --- 10 ohms 1/4w
	DR21 --- 100K, 3/4w, 3/4 TURN
	DC1, DC2, DC3, DC4, DC5, DC6, DC13, DC15,
	DC16, DC17, DC18, C19 --- 47uf, 16 volts
15	DC7, DC8, DC9, DC10, DC11, DC12 --- .01uf, 50 volts
	DC14, DC20 --- .033uf, 50 volts
	DD1, DD2, DD3 --- 1N4148
	DQ1, DQ2 --- 2N2222
	DVR1 --- 1N5245
20	DU1, DU2, DU3, DU5 --- LM324N
	DU4 --- LM339N
	DU6 --- LM78L08
	DPY1, DPY2 --- P2288, Hammamatsu
	DLED1, DLED2 --- LN29RPP, Panasonic
25	DSP1 --- EFB-RD24C411, Panasonic
	DSW1 --- GSR-4011-1600, CW Industries
	lens 109 and 111 --- DWA 1.2 GI 12 V1, Fresnel Technologies

Referring to FIGURE 10, a generalized schematic of the control achievable using the components discussed thus far, is illustrated.

Preferably, the alert signal produced at the base of transistor SQ1 of FIGURE 8 will be correlated to the input signal level in order to provide a quantitative alert signal. In one embodiment of the invention, the amenity control 107 further includes an electrical interconnection for communicating with auxiliary vehicle systems and alarms as are shown in FIGURE 10. For example, at the left side of the diagram is the amenity control 107 shown connected to the gate of field effect transistor 115. The drain of the field effect transistor 115 is connected to the supply voltage through a resistor 117. The drain the field effect transistor 115 is connected to an input of a digital central processing unit 121.

Other inputs to the digital central processing unit

121 might include the vehicle ignition switch signal, a radio frequency receiver 123, or a series of inputs supplied by a selector switch 125 in combination with a series of lines 127, each having a resistive connection with a supply voltage, which connect the supply voltage through appropriate resistances to the digital central processing unit 121.

Outputs might include connection to a radio frequency oscillator 129, which could share an antenna 131 with receiver 123, the gate of a field effect transistor 133 could be connected to power a siren 135, or the gate of a field effect transistor 137 could be connected to power a convenience light 141. A remote transceiver 145 could be utilized to communicate through antenna 131 and the radio frequency oscillator 129 and radio frequency receiver 123 with the digital central processing unit 121.

The two-way electronic control achievable with the transceiver 145 may be included for interactive control of the security system from a position exterior to the vehicle 21 and for enabling an alarm device positioned exterior to the vehicle 21. In practice, the brightness of the visual indicator 109 and the volume of the audio alert 113 may be correlated to the distance of the intruder away from the sensor 31, the speed at which the intruder is moving, or the like.

Another possible configuration is dual, largely digital and is shown beginning with FIGURE 11. A first sensor board 151 supports a sensor 131 having lens 109, while a second sensor board 153 supports an identical sensor 131 having lens 111. Sensor board 151 connects into a first window comparator 155 while second sensor board 153 connects into a second window comparator 157. Both first and second window comparators 155 and 157 are connected in parallel to a sensitivity control 159. The sensitivity control could be the sensitivity dial 71 shown in FIGURE 7. Both first and second window comparators 155 and 157 are also connected to a microprocessor 161. The microprocessor 161 receives

inputs from a set of mode switches 163, and also receives both inputs and outputs from a transceiver 165. Transceiver 165 utilizes antenna 171. A power supply 173 is utilized to supply power to the system of Figure 11.

A portable unit utilizable in much the same way as the single sensor circuit of FIGURE 8 is illustrated beginning with FIGURE 12. The internals of the portable unit would comprise many of the same components as were shown, perhaps with substitutions due to the small size needed for a portable unit.

FIGURE 12 is a plan view of a portable sensor 201 which is specifically designed to hang over a window of vehicle 21. A sensor window 203 is supported by a sensor support portion 205 which is set away from a main housing 207. An on/off switch 209 is seen protruding to the right in FIGURE 12.

Further details of the portable sensor 201 may be seen with respect to FIGURE 13, which depicts a rear view of the portable sensor 201 and includes a speaker grille 211, light emitting diode 213, an audio on/off switch 215, and a sensitivity control 217.

The side view shown in FIGURE 14 makes clear the manner of use of portable sensor 201. The side profile is in the shape of an inverted "U" which will accept a vehicle window glass 221, shown in sectional view. In this fashion, the portable sensor 201 can be placed over a vehicle 21 window glass 221, the window glass 221 then being raised almost to closing. This configuration protects the portable sensor 201 against theft, as well as to provide a secure support from which thermal flux is to be measured. The portable sensor 201 can be utilized and adjusted from within the vehicle 21, while an occupant within the vehicle 21 remains secure. Lowering the window glass 221 is all that is necessary to release the portable sensor 201. Preferably the housing 207, including the sensor support portion 205 may be made of reinforced materials which would help prevent the portable sensor 201 from being vandalized.

While the invention has been described with reference to a preferred embodiment, it is to be clearly understood by those skilled in the art that the invention is not limited thereto. Rather, the scope of
5 the invention is to be interpreted only in conjunction with the appended claims.

While the present invention has been described in terms of an vehicle alarm system, one skilled in the art will realize that the structure and techniques of the
10 present invention can be applied to many structures and situations. The present invention may be applied in any situation where the approach of intruders is to be detected or detected and reacted to.

Although the invention has been derived with
15 reference to particular illustrative embodiments thereof, many changes and modifications of the invention may become apparent to those skilled in the art without departing from the spirit and scope of the invention. Therefore, included within the patent warranted hereon
20 are all such changes and modifications as may reasonably and properly be included within the scope of this contribution to the art.

WHAT IS CLAIMED:

1. A security system for a vehicle (21) comprising:
 - sensor means (31) for detecting a thermal energy flux radiated from at least one individual approaching a direction (41) of interest with respect to a vehicle (21), and for producing an output signal associated with said thermal flux;
 - indicator means (65), communicating with said sensor means (31), for receiving said output signal and indicating the presence of said at least one individual.
2. The security system recited in claim 1 wherein said sensor means (31) further comprises:
 - an infrared detector (131) having an output; and
 - electronic means (155, 157), communicating with said infrared detector, for detecting the signal level of said infrared detector (131) output and for comparing it with a preselected trigger level (159), and for producing an alert signal if the signal level of said infrared detector (131) exceeds the trigger signal level (159).
3. The security system recited in claim 2 wherein said output of said infrared detector (131) is a varying voltage level and wherein said electronic means (155, 157) further comprises:
 - an amplifier (151, 153), having an input connected to said infrared detector (131) to receive and amplify said varying voltage level, and an output;
 - a comparator (155, 157), having an input connected to said output of said amplifier (151, 153) and an output, to compare the amplified variable voltage level to a voltage reference;
 - a power driver (121) having an input connected to said output of said comparator, and an output, for

powering equipment to operate in response to the detection of a preselected level of said thermal flux.

4. The security system for a vehicle (21) of claim 1 wherein the sensor means (31) includes a lens means (109, 111) for providing high directional definition in receiving the thermal energy flux.

5. The security system for a vehicle (21) of claim 1 wherein the sensor means (31) includes a lens means (109, 111) for providing high directional definition in receiving the thermal energy flux.

6. The security system for a vehicle (21) of claim 5 wherein the means for providing high directional definition in receiving the thermal energy flux segregates said sensor means (31) into zones (33, 35) of azimuth.

7. The security system for a vehicle (21) of claim 6 wherein the zones of azimuth (33, 35) overlap each other.

8. The security system for a vehicle (21) of claim 5 wherein the means for providing high directional definition in receiving the thermal energy flux segregates said sensor means (31) into zones of elevation (47, 49, 51) to provide additional sensitivity.

9. The security system for a vehicle (21) of claim 1 wherein said lens means (109, 111) further comprises a fresnel lens (109, 111).

10. The security system for a vehicle (21) of claim 1 wherein the indicator means (65) further comprises a visual indicator means (67, 69) for producing a brightness proportional to the distance of the at least one individual to the sensor means (31).

11. The security system for a vehicle (21) of claim 1 wherein the indicator means (65) further comprises an audible signal indicator means (211) for producing a sound level proportional to the distance of the at least one to the sensor means (31).

12. The security system for a vehicle (21) of claim 1 wherein the indicator means (65) further comprises a visual indicator means (67, 69) for indicating the approximate location of the at least one to the sensor means (31).

13. The security system for a vehicle (21) of claim 1 wherein the indicator means (65) is self powered and portable, communicating with said sensor means (31) using radio communication.

14. The security system for a vehicle (21) of claim 1 wherein the sensor means (31) is self powered and portable.

15. The security system for a vehicle (21) of claim 1 wherein the sensor means (31) communicates with said indicator means (65) using radio communication.

16. The security system for a vehicle (21) of claim 1 wherein said sensor means (31) further comprises a sensor (23) having magnetic attachment means (25) , attached to said sensor (23), for attachment to a surface from which monitoring is to take place.

5 17. The security system for a vehicle (21) of claim 1 wherein said sensor means (31) further comprises a plurality of sensors (23), each having magnetic attachment means (25), attached to each of said plurality of sensors (23), for attachment to a surface from which monitoring is to take place.

18. The security system for a vehicle (21) of

claim 1 wherein said indicator means (65) further comprises a visual indicator means (67, 69) for visually indicating which of said plurality of sensors (23) indicates the presence of said at least one individual.

19. The security system for a vehicle (21) of claim 1 wherein said visual indicator means (65) contains a spatial representation of the spatial location of said plurality of sensors (23), in order to
5 for visually indicate the spatial orientation of the presence of said at least one individual.

20. The security system for a vehicle (21) of claim 1 further comprising a housing (53) covering said sensor means (31) and having at least one aperture (61) to permit the introduction of thermal flux into said housing (53).

21. The security system for a vehicle (21) of claim 13 wherein said housing further (53) comprises:
a planar base; and
a shell matable (53) with said base having a rear
5 side defining a pair of windows (61) separated by a support and a front side.

22. The security system for a vehicle (21) of claim 15 wherein said housing further comprises a fresnel lens covering each of said pair of windows (61).

23. The security system for a vehicle (21) of claim 1 wherein the sensor means (31) includes a frequency selective amplification means for preventing false triggering of said sensor means (31) due to signal
5 drift from ambient temperature changes and high frequency signals.

24. The security system for a vehicle (21) of claim 1 further comprising a housing having a first portion for receiving thermal flux radiation and a

5 second portion for supporting said indicator means (65),
said sensor means (31) supported in at least one of said
first portion and said second portion.

25. The security system for a vehicle (21) of
claim 24 where said housing is "U" shaped and where said
first portion forms one side of said "U" shape and said
second portion forms the other side of said "U" shape.

26. A security system for a vehicle (21)
comprising:

5 a plurality of sensor means (31), each said sensor
means (31) for detecting a thermal energy flux radiated
from a direction of interest, and for producing an
electrical input signal associated with the flux, the
signal having an input signal level, the plurality of
sensor means (31) interconnected with;

10 an electronic means for detecting each of the input
signal levels and for comparing each one of the input
signal levels with a preselected trigger level, and for
producing an alert signal if at least one of the input
signal levels becomes equal to the trigger signal level,
the electronic means further including;

15 an alarm means (201) for receiving the alert signal
and for producing a warning effect detectable by an
occupant within the vehicle (21) such that the occupant
is made aware that an intruder may be in the vicinity of
the vehicle (21).

27. The security system for a vehicle (21) of claim
26 wherein the trigger level signal means is adjustable
such that the occupant may select an alarm threshold in
order to exclude thermal noise related false alarms and
5 alarms triggered by small animals.

28. A process of monitoring the area about a
vehicle (21) comprising the steps of:

10 monitoring in a direction rearwardly of a vehicle
(21) for infrared flux;

upon detecting said infrared flux, transmitting a signal to an indicator to alert the presence and location of said infrared flux.

29. The process of monitoring the area about a vehicle (21), as recited in claim 28, and further comprising the step of indicating the rate of approach of said infrared flux.

Figure 1

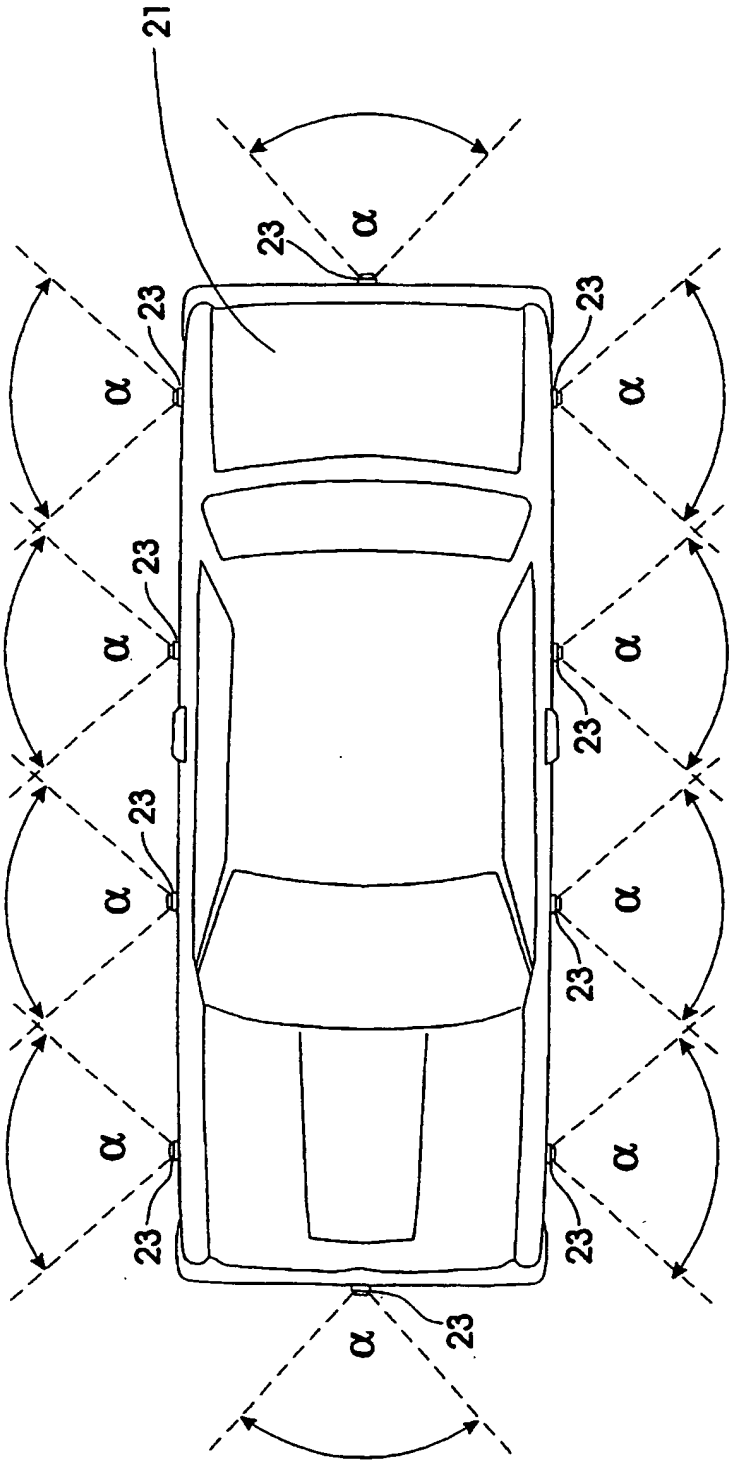


Figure 2

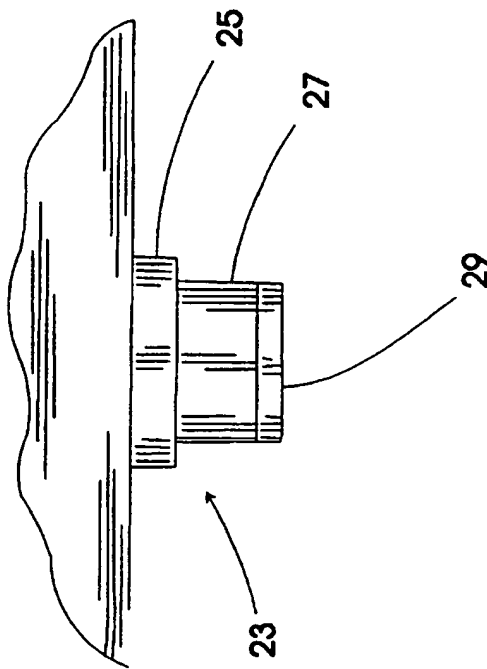
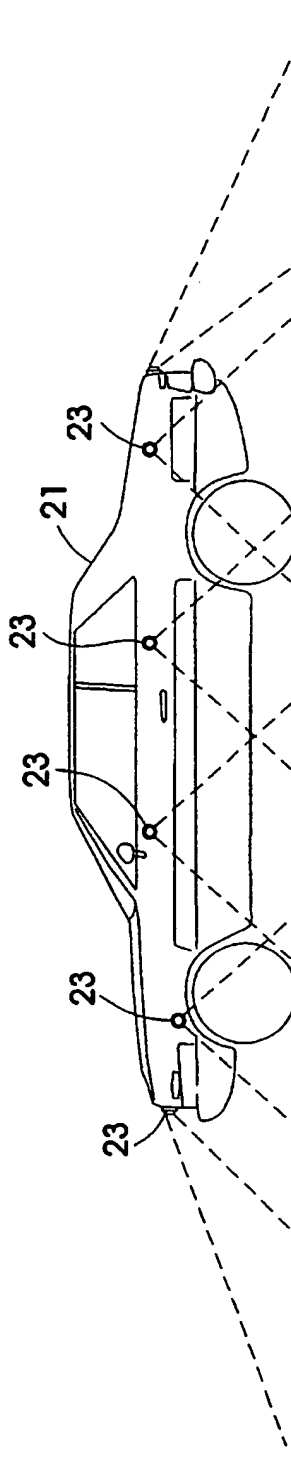


Figure 3



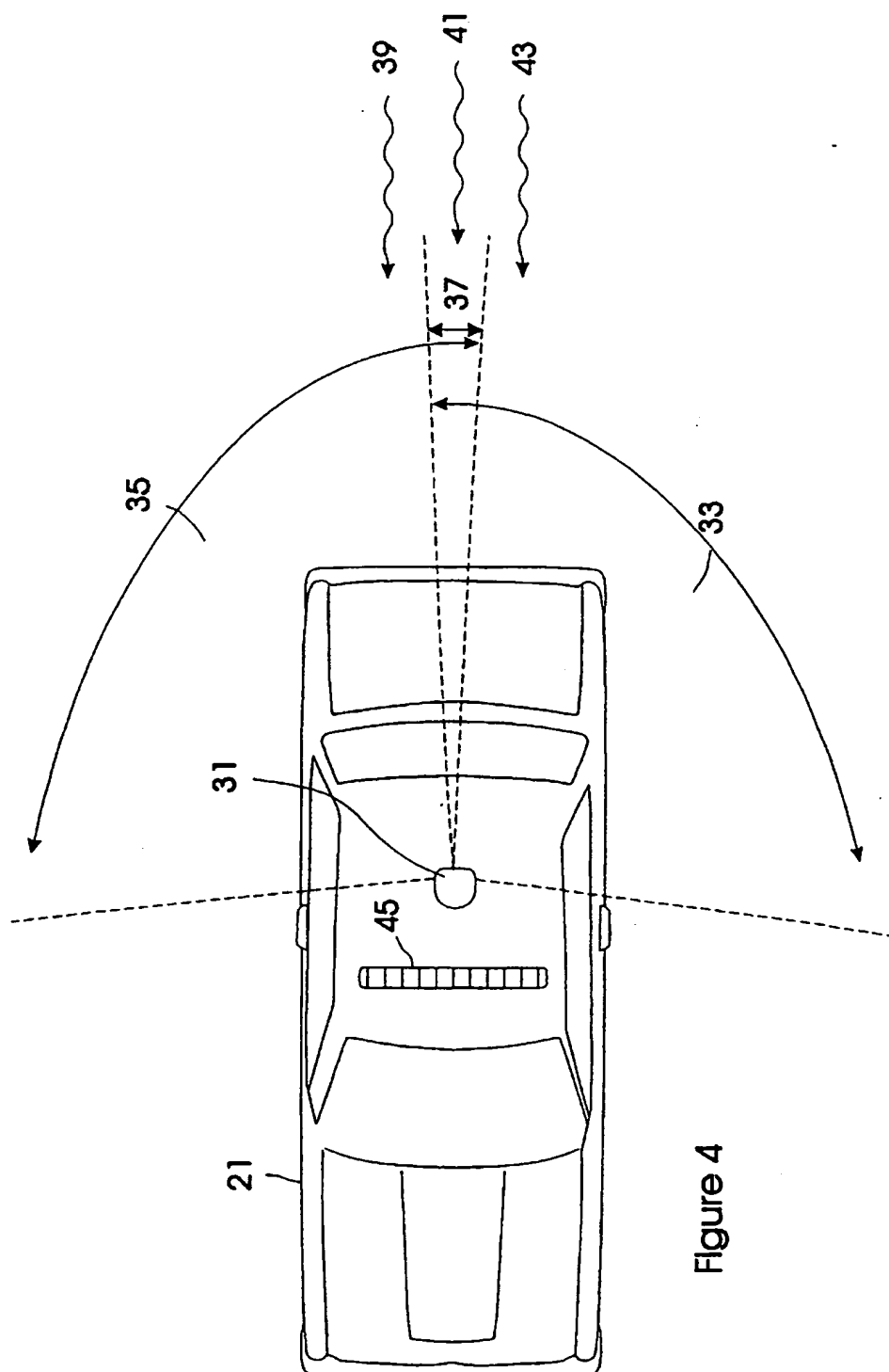
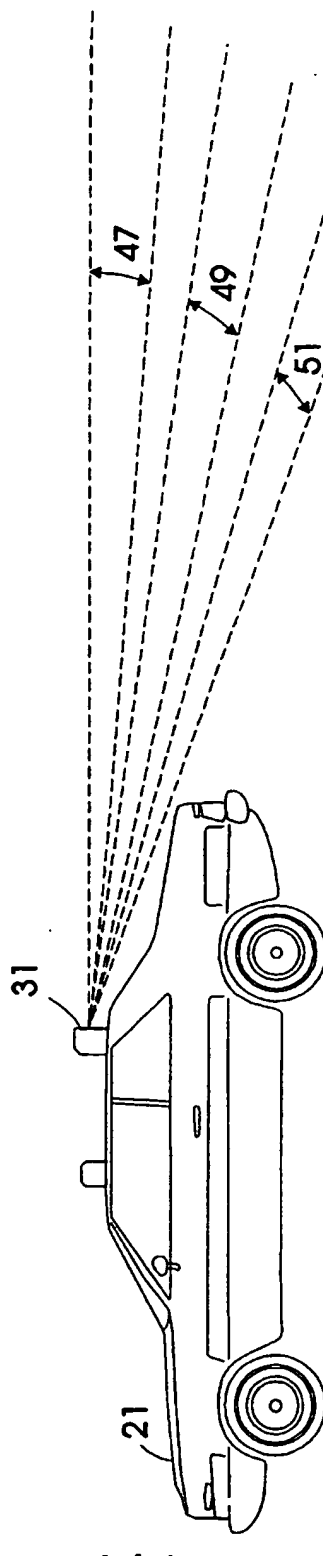


Figure 4

Figure 5



5 / 14

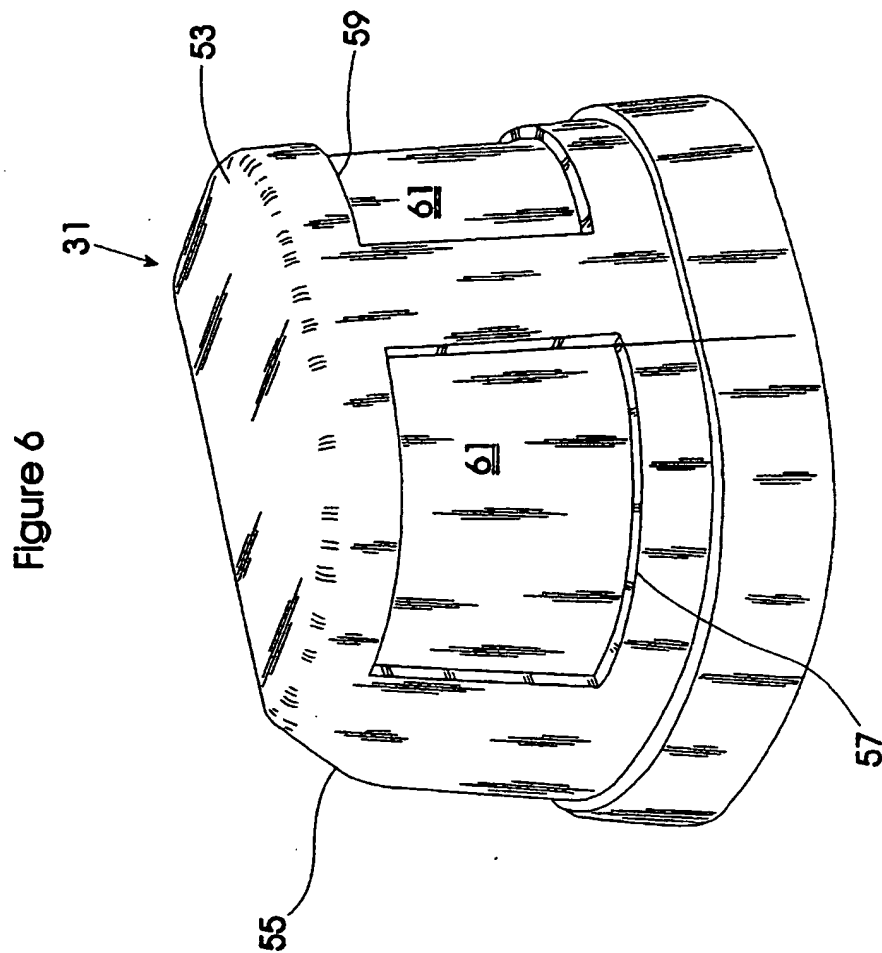
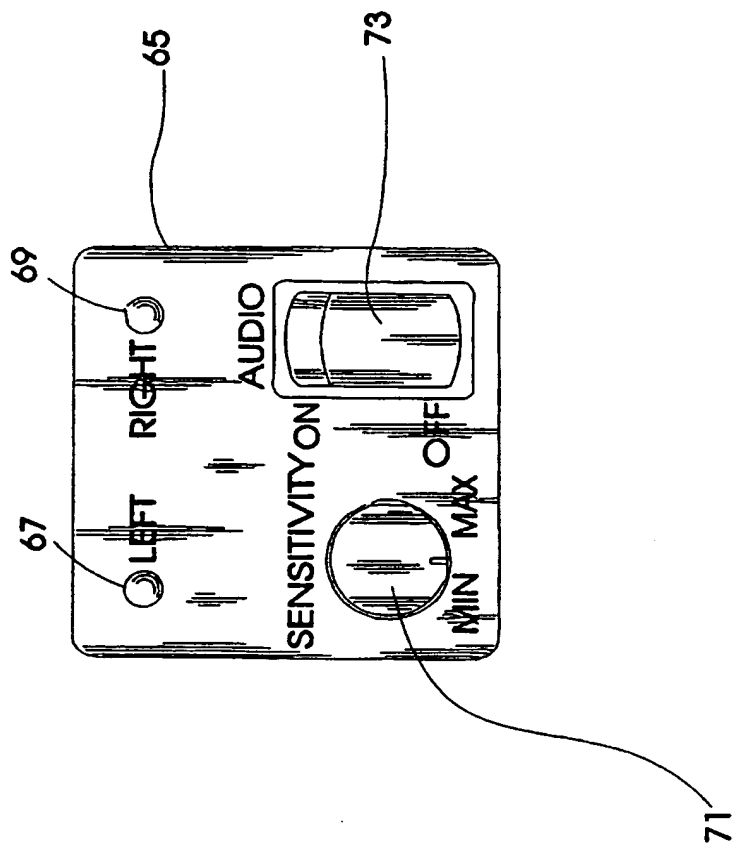


Figure 7



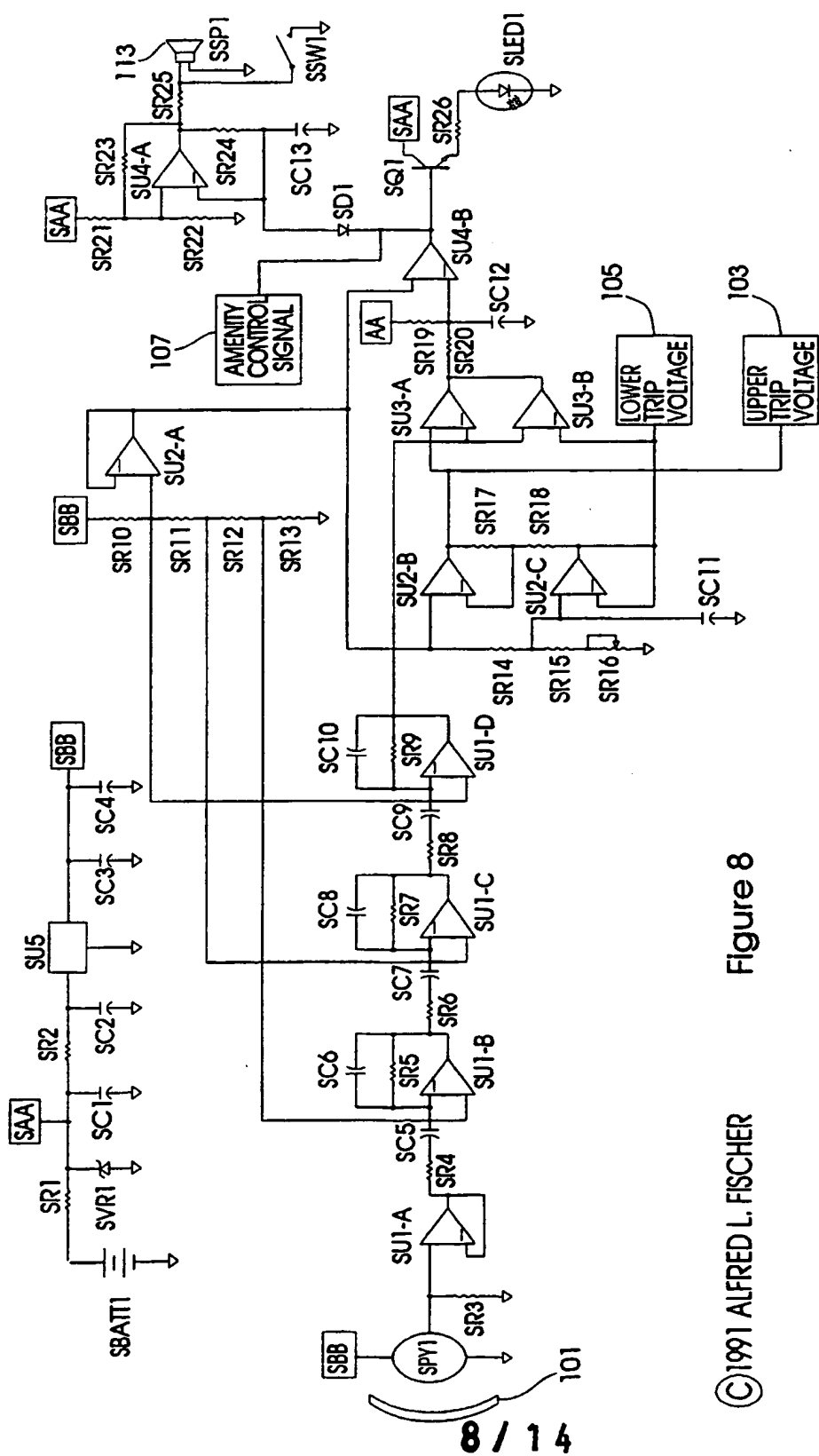


Figure 8

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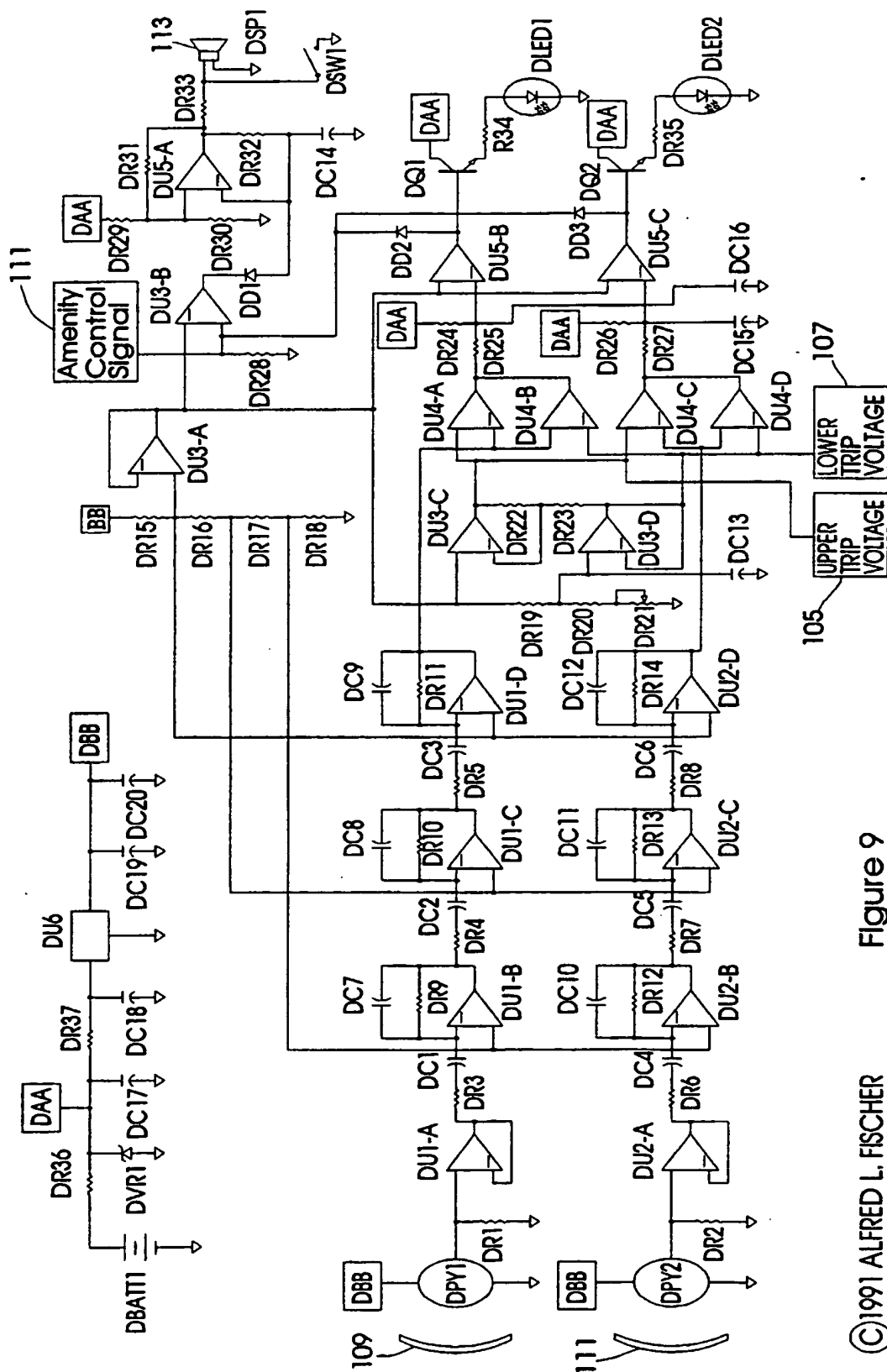


Figure 9

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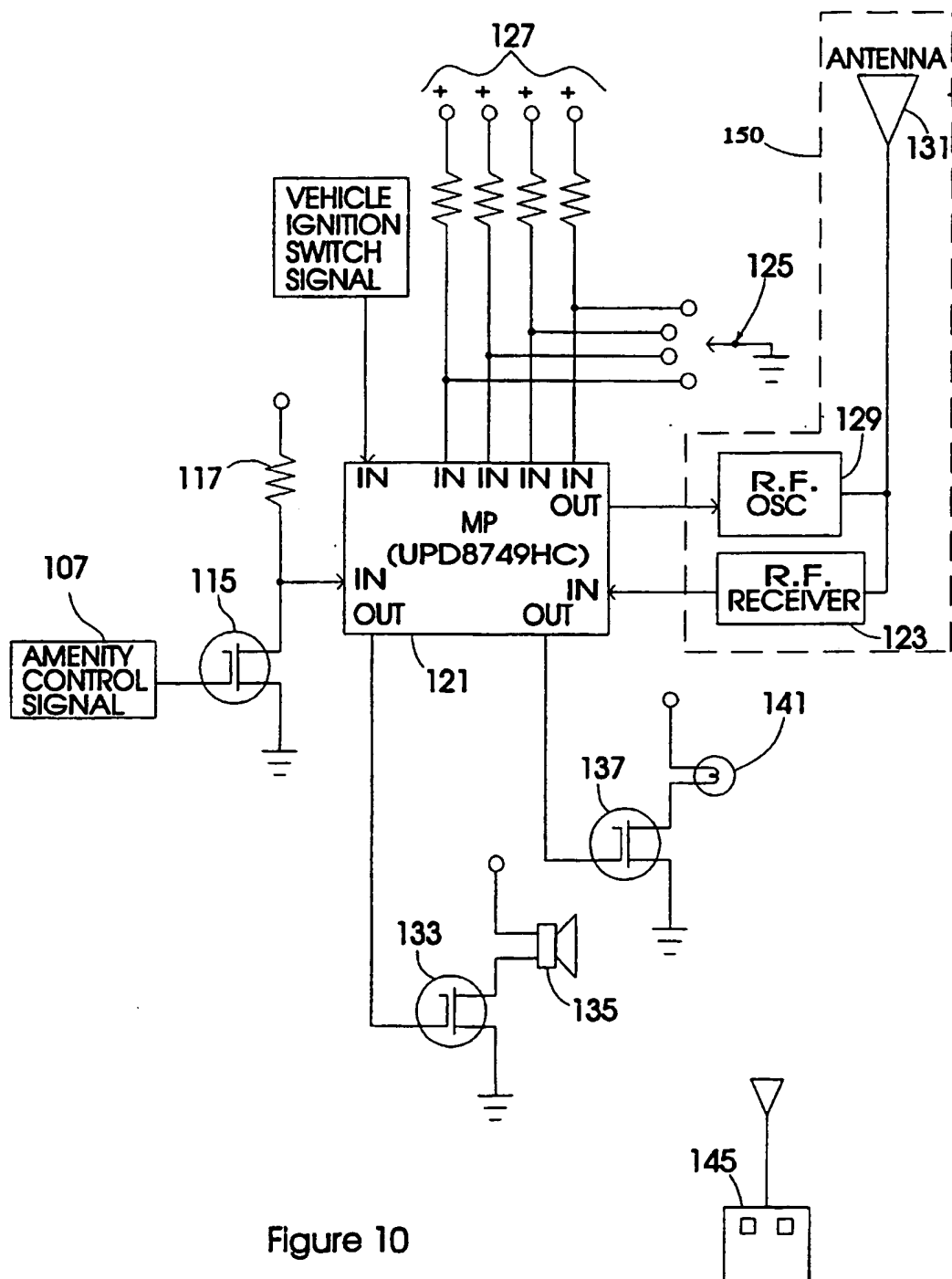


Figure 10

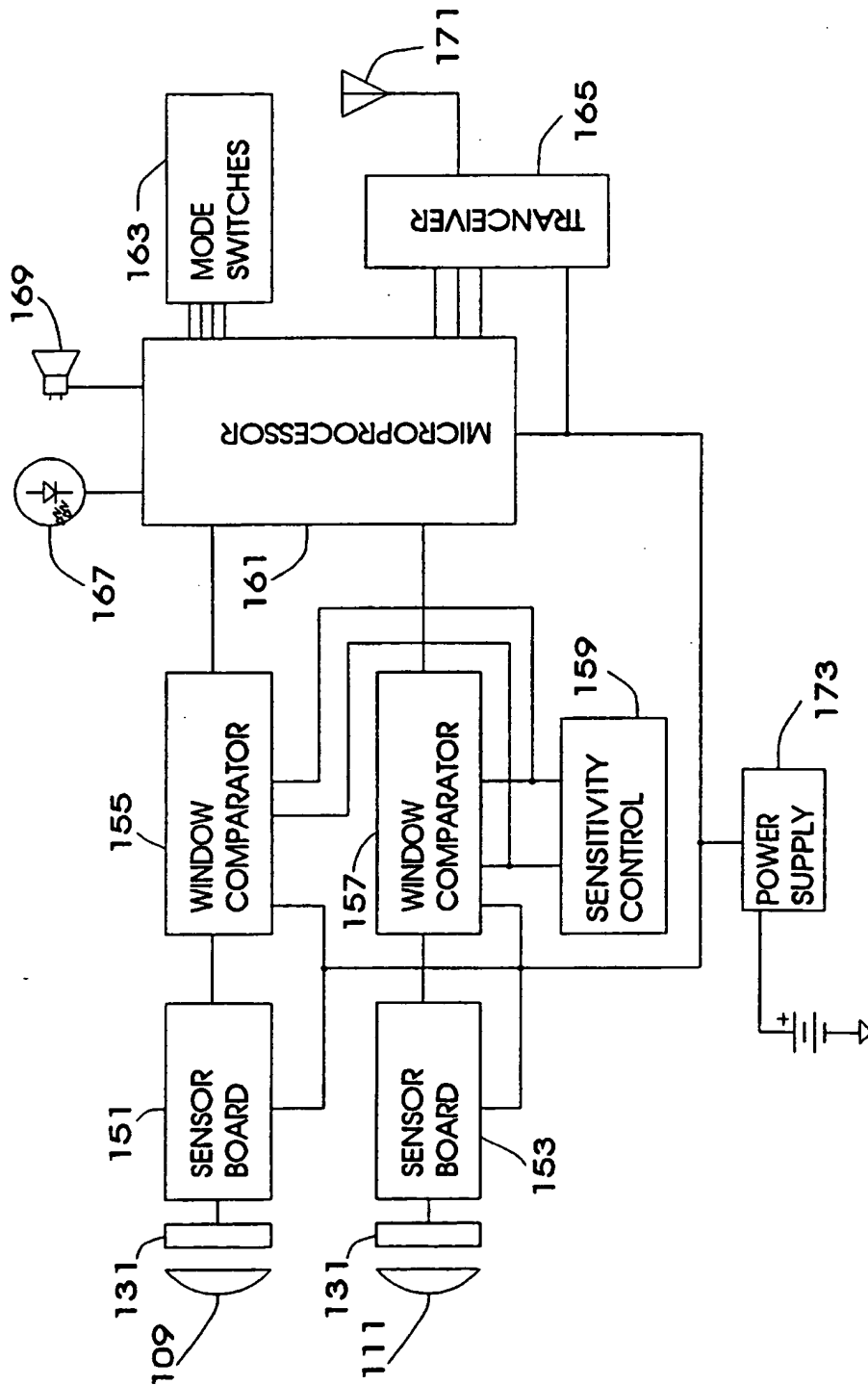


Figure 11

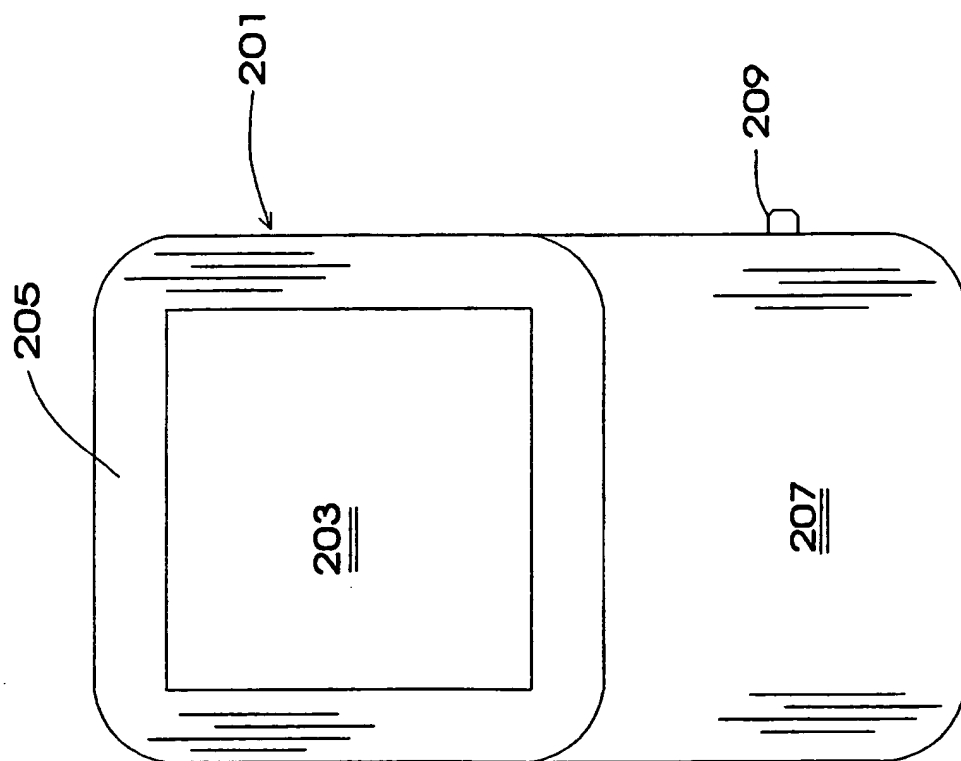
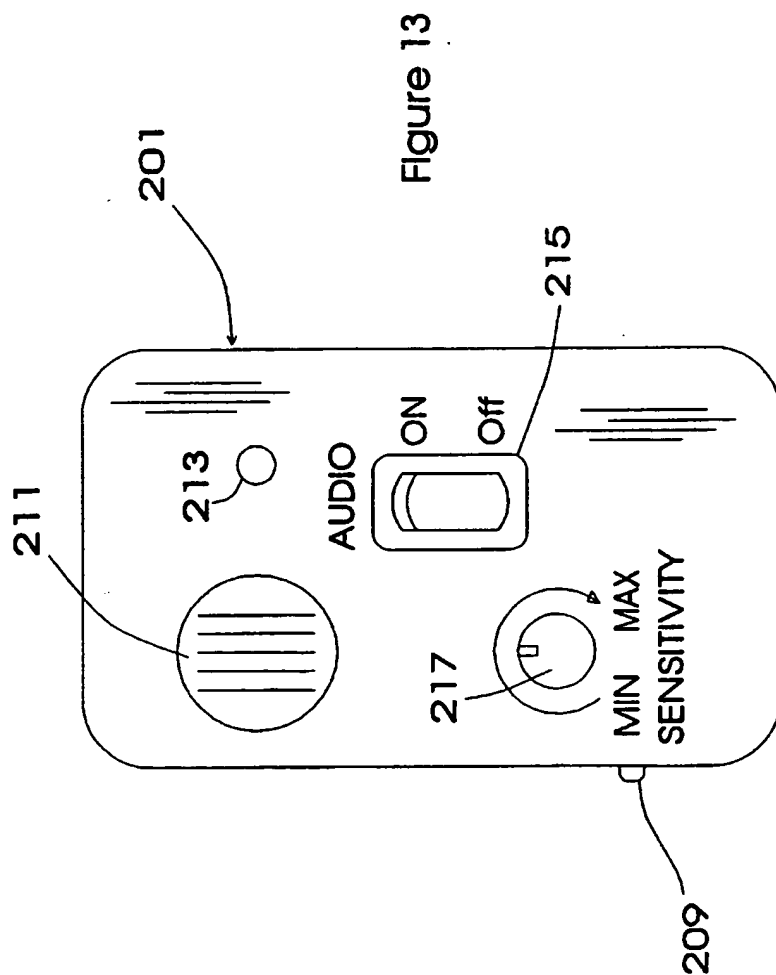


Figure 12



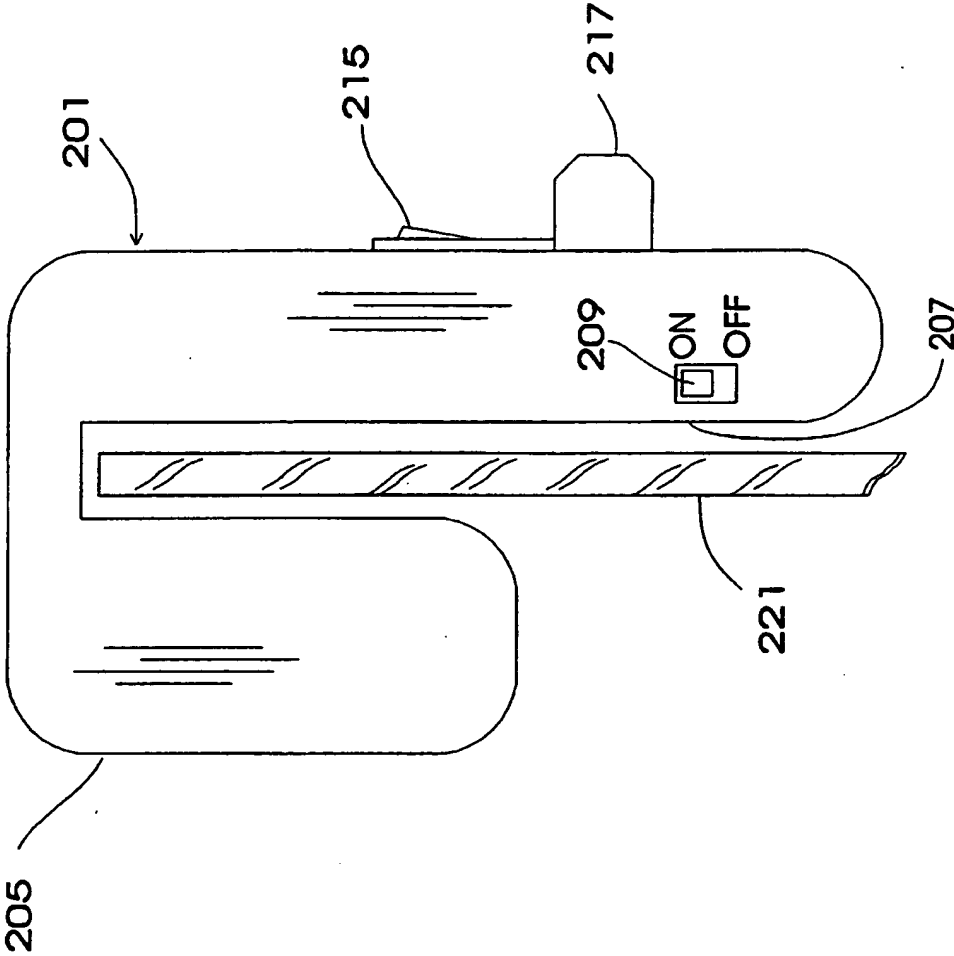


Figure 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/07067**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(5) :B60Q 1/00; G08B 13/18

US CL : 340/436,425.5,426,433,901,541,555,565; 250/336.1,DIG.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 340/436,425.5,426,433,901,541,555,565,435,438,447,902-904,531,692; 250/336.1,DIG.1,316.1,332

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,117,217 (NYKERK) 26 MAY 1992 col. 4, lines 1-30; cols. 5-8.	1-27,29,30
Y	US, A, 5,084,696 (GUSCOTT ET AL) 28 JANUARY 1992, col. 2, lines 7-34; col. 3.	1-27,29,30
Y	US, A, 4,321,594 (GALVIN ET AL) 23 MARCH 1982, col. 2, lines 24 et seq.	4-9
Y	US, A, 5,059,946 (HOLLOWBUSH) 22 OCTOBER 1991, abstract, col. 2, lines 3-20.	10,11,30

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search

23 SEPTEMBER 1994

Date of mailing of the international search report

20 OCT 1994

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/07067

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,842,397 (SINDLE) 15 OCTOBER 1974 fig. 5, col.1, lines 39-43.	12,16-19
Y	US, A, 5,061,917 (HIGGS ET AL) 29 OCTOBER 1991, col. 1, lines 31-40, col. 2, lines 33-65.	13-15
Y	US, A, 4,694,295 (MILLER ET AL) 15 SEPTEMBER 1987, fig. 2, col. 4, lines 25-27; col. 5, lines 1-17.	20,21
Y	US, A, 5,119,069 (HERSHKOVITZ ET AL) 02 JUNE 1992, col. 1, lines 16-45.	24,25
X	US, A, 3,491,334 (MARTIN) 20 JANUARY 1970 col. 1, lines 14-20.	29
A	US, A, 5,181,010 (CHICK) 19 JANUARY 1993, ENTIRE DOCUMENT	1-27,29,30
A	US, A, 4,772,875 (MADDOX ET AL) 20 SEPTEMBER 1988, ENTIRE DOCUMENT	1-27,29,30
A	US, A, 4,339,748 (GUSCOTT ET AL) 13 JULY 1982, ENTIRE DOCUMENT	1-27,29,30

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